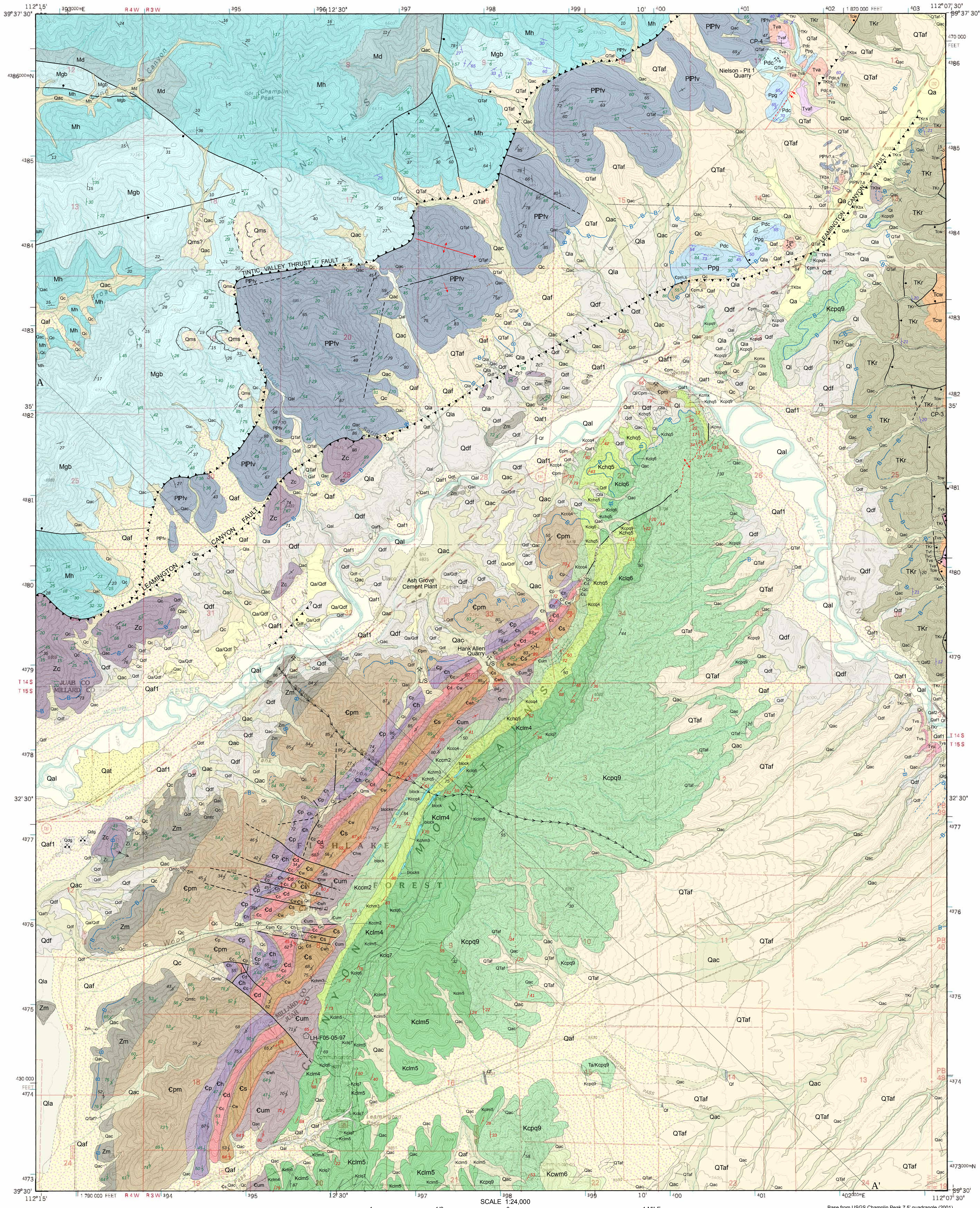
Plate 1
Utah Geological Survey Miscellaneous Publication 08-1
Provisional Geologic Map of the Champlin Peak Quadrangle



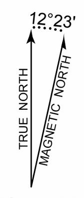
SCALE 1:24,000

1 — 1/2 — 0 — 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
SUPPLEMENTAL CONTOUR INTERVAL 10 FEET



APPROXIMATE MEAN DECLINATION, 2008

PROVISIONAL GEOLOGIC MAP OF THE CHAMPLIN PEAK QUADRANGLE, JUAB AND MILLARD COUNTIES, UTAH

by

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Base from USGS Champlin Peak 7.5' quadrangle (2001)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1886

Field mapping by authors: 1980-1981 (Hayden), 1996-1997, 1999 (Lawton), 2004-2005 (Clark)
GIS and Cartography: Darryl Greer, Kent Brown, Buck Ehler, Donald Clark and Lori Douglas

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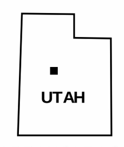
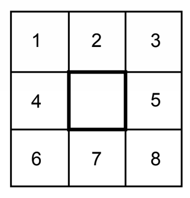
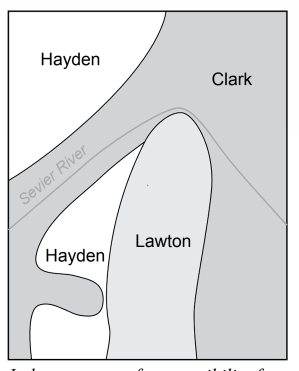


QUADRANGLE LOCATION



1 Tanner Creek Narrows
2 Jericho
3 Furner Ridge
4 Lynndyl East
5 Sage Valley
6 Oak City North
7 Fool Creek Peak
8 Mills

ADJOINING 7.5' QUADRANGLE NAMES



Index to areas of responsibility for geologic mapping in this quadrangle

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a division of
Utah Department of Natural Resources

INTRODUCTION

This geologic map combines and updates prior mapping in the geologically complex and diverse Champlin Peak quadrangle. The map and associated materials combine the 1:24,000-scale mapping and report by Hayden (Higgins, 1982), which focused on the Proterozic and Paleozoic bedrock, and the studies of synorogenic conglomerates of the Canyon Mountains by Lawton and others (1997) including unpublished 1:24,000-scale mapping by Lawton. This map extends the mapping of Clark (2003) from the east in Sage Valley, and incorporates some interpretations of structural geology by Kwon (2004) and Kwon and Mitra (2007) in Leamington Canyon and the Gilson Mountains. Author Clark updated the mapping of surficial deposits, Tertiary rocks, and some older bedrock units, and compiled the mapping data (see Index Map of Mapping Sources). Lawton and Clark prepared the cross section. The map also includes new stratigraphic terminology for the Canyon Range Conglomerate developed by Lawton and others (2007).

This mapping supercedes that of Higgins (1982) relative to surficial deposits and Tertiary rocks, and locally some Proterozoic and Paleozoic bedrock, supercedes that of Lawton and others (1997) as depicted in their figure 14 and that part of their figure 12 covered by this quadrangle, and also supercedes some map border matches with Clark (2003). We recognize the contributions of Kwon (2004), Kwon and Mitra (2005), and Kwon and Mitra (2007) on the structural geology of the Gilson and northern Canyon Mountains, but chose not to include their geologic mapping data (contacts and faults) other than selected bedding attitudes and some limited structural data. The structural aspects of the quadrangle are complex and we do not completely address them herein.

Further, the mapping discrepancies in the quadrangle between Higgins (1982), Lawton and others (1997), and Hintze and Davis (2002) have not been fully resolved here. Although greater overall geologic detail is presented by the aforementioned references, the map unit descriptions herein supercede them, as well as those in the Delta 30' x 60' quadrangle (Hintze and Davis, 2002) and the Millard County Bulletin (Hintze and Davis, 2003). Differences between Higgins' measured section (1982, appendix B) and Lawton's Canyon Range Conglomerate mapping are indicated in table 1. The part of Higgins' (1982) map north of the Leamington Canyon fault was adapted from Costain (1960) and Wang (1970). Clark reinterpreted some of the eastern exposures of this area, but did not revisit western exposures there.

Finally, an important aspect of the quadrangle is the location of the Ash Grove Cement Company - Leamington plant (located at the Uisco rail siding). The cement plant was sited so that it is near a main railroad line and for ready access to feedstocks of lime, shale, and silica located within or near the quadrangle. Abbay (1990), Godek (2003), and Tripp (Utah Geological Survey, written communication, December 4, 1992; 2005) reported on economic commodities in the Champlin Peak quadrangle.

MAP UNIT DESCRIPTIONS

Descriptions for Quaternary, Quaternary-Tertiary, Tertiary, and Tertiary-Cretaceous map units are by author Clark. Descriptions for Cretaceous map units are from author Lawton. Descriptions of older map units of the para-autochthon, Tintic Valley thrust plate, and Canyon Range thrust plate were modified from Higgins (1982) by author Clark.

QUATERNARY

Alluvial deposits

Qal **River and stream alluvium** (Holocene) – Moderately to well sorted sand, silt, and clay with local coarse lags of pebble to boulder gravel along the Sevier River and other active streams including the Gilson Wash area and Pass Canyon; includes minor terraces up to 10 feet (3 m) above current drainage levels; total thickness unknown, up to 10 feet (3 m) exposed.

Qat **Stream-terrace deposits** (Holocene) – Fine- to coarse-grained deposits that form a level to gently-sloping stream terrace incised by the Sevier River near the western border of the quadrangle; terrace is from 10 to 20 feet (3-6 m) above current river channel; thickness 0 to 20 feet (0-6 m).

Qa **Young alluvial deposits** (Holocene to upper Pleistocene?) – Fine- to coarse-grained, poorly-sorted alluvium in Dog Valley Wash below the Bonneville shoreline; includes overlapping stream and alluvial-fan deposits and some small colluvial deposits; flat bottom profile in drainage is incised by active stream; grades to alluvium-colluvium; thickness variable and probably less than 100 feet (<30 m) in most places.

Qaf$_1$ **Young alluvial-fan deposits** (Holocene) – Poorly sorted sand and gravel with silt and clay in active alluvial fans adjacent to steeper uplands; composed of locally-derived rock types; forms broad surfaces in Leamington and Sevier Canyons that are incised by the Sevier River; thickness probably less than 100 feet (<30 m).

Qaf$_2$ **Older alluvial-fan deposits** (middle and lower Holocene) – Similar in composition to young alluvial-fan deposits; mapped only along the Sevier River near the eastern quadrangle border; locally incised by stream and river alluvium; exposed thickness probably less than 100 feet (<30 m), total thickness unknown.

Qaf **Alluvial-fan deposits, undifferentiated** (Holocene to lower Pleistocene?) – Poorly sorted sand and gravel with silt and clay; consists of a mix of coalesced older fans and younger fans than cannot be readily mapped separately; present in or emanating from Sevier, Leamington, Wood, and Pass Canyons and may include some pre-Lake Bonneville alluvial deposits; grades to alluvium-colluvium and mixed lacustrine-alluvial deposits; locally incised by Holocene drainages; exposed thickness probably less than 200 feet (<60 m), total thickness unknown.

Deltaic and Lacustrine deposits

These deposits likely represent the transgressive phase of Lake Bonneville, near its highest level prior to the Bonneville Flood (Oviatt, 1992; Oviatt and others, 1992).

Qdf **Deltaic (estuarine) fines** (upper Pleistocene) – Fine sand, silt, and clay that is thinly to very thickly bedded with a local layered appearance; forms an upward-fining sequence; deposited in the Sevier River estuary of Lake Bonneville about 15,000 years ago (Oviatt, 1992) below the Bonneville shoreline (elevation of approximately 5100 feet [1555 m]); locally covered by an expansive soil with a significant shrink-swell potential--cement plant structures built on this unit have settled (Jeffrey Peterson, Ash Grove Cement Company, verbal communication, 2004); up to about 250 feet (75 m) exposed, total thickness uncertain.

Qdg **Deltaic gravels** (upper Pleistocene) – Well sorted and rounded, sandy, pebble-size gravel deposits near the mouth of Leamington Canyon; deposited in a delta of the Sevier River entering Lake Bonneville; exposures appear to have been largely removed through excavation; up to about 30 feet (10 m) removed, total thickness uncertain.

Qlg **Lacustrine gravels** (upper Pleistocene) – Well sorted and rounded, sandy, pebble-size gravel deposit in Sevier Canyon on east margin of map; developed at the Bonneville shoreline; less than 20 feet (<6 m) exposed, total thickness uncertain.

Ql **Lacustrine deposits, undifferentiated** (upper Pleistocene) – Fine-grained sediment to gravel deposited below the Bonneville-level shoreline in lacustrine or estuarine environment(s); derived from local rocks and deposits that form a mantle obscuring bedrock; mapped in northern Sevier Canyon; some unmapped thin deposits occur on bedrock below the Bonneville shoreline in Leamington and Sevier Canyons; thickness likely less than 25 feet (<8 m).

Colluvial deposits

Qc **Colluvial deposits** (Holocene to Pleistocene?) – Slopewash deposits of clay- to boulder-size, locally derived sediments; poorly to moderately sorted and angular; deposited on and at the base of upland slopes; locally may include small unmapped areas of alluvial deposits or talus; grades downslope to alluvial-fan and alluvial-colluvial deposits and locally upslope to mixed talus and colluvial deposits; generally less than 20 feet (<6 m) thick.

Mixed-Environment deposits

Qac **Alluvial and colluvial deposits** (Holocene to Pleistocene?) – Combined alluvial and slopewash deposits of poorly to moderately sorted, generally poorly stratified, clay- to boulder-size, locally derived sediments; present along drainages in uplands, locally within larger canyons, and incised into QTaf surface; grades to alluvial-fan deposits; locally incised by Holocene drainages; generally less than 20 feet (<6 m) thick.

Qla **Lacustrine and alluvial deposits** (Holocene to Pleistocene?) – Clay- to boulder-size deposits that consist of pre-Lake Bonneville alluvial fans partially reworked in the Sevier River estuary, and Lake Bonneville deposits partially reworked and covered by post-Bonneville alluvial activity; locally grades to alluvial fans; mapped below the Bonneville shoreline in Leamington Canyon and west of the Canyon Mountains; thickness less than 100 feet (<30 m).

Qmtc **Talus and colluvial deposits** (Holocene to Pleistocene?) – Poorly sorted, angular to subangular cobbles and boulders and finer grained interstitial sediment deposited by rock fall and slopewash on and at the base of steep slopes; generally grades downslope from talus to colluvial deposits; a few areas mapped near Wood and Tank Canyons; generally less than 25 feet (<8 m) thick.

Mass-Movement deposits

Qms **Landslide deposits** (Holocene? to upper Pleistocene?) – Rotational and complex slumps and slides; variable grain size and texture; developed on steeper slopes in the Great Blue Formation; present in and near Gilson Wash and along the Tintic Valley thrust fault; queried where presence uncertain; thickness variable.

Human-Derived deposits

Disturbed land associated with the Ash Grove Cement Company's Hank Allen quarry area (sections 32 and 33, T. 14 S., R. 3 W. and section 4, T. 15 S., R. 3 W.) and Nielson quarry - Pit 1 area (section 11, T. 14 S., R. 3 W.) has not been mapped in detail.

Qf **Fill** (Historical) – Local earth materials used to construct dams for stock ponds and berms to divert drainages; thickness 0 to 20 feet (6 m).

Stacked-Unit deposits

Qa/Qdf **Alluvial deposits over deltaic (estuarine) fines** (Holocene/upper Pleistocene) – Veneer of fine-grained alluvial deposits overlying Lake Bonneville deltaic fines; several areas mapped in Leamington Canyon; surficial deposit thickness probably less than 10 feet (<3 m).

Ql/Ꞓpm **Lacustrine deposits over Prospect Mountain Quartzite** (upper Pleistocene/lower Cambrian) – Veneer of fine- to coarse-grained lacustrine or estuarine deposits overlying bedrock unit of Prospect Mountain Quartzite; only mapped near Soma siding; surficial deposit thickness probably less than 10 feet (<3 m).

QUATERNARY-TERTIARY

QTaf **Oldest alluvial-fan deposits** (lower Pleistocene? to Pliocene?) – Fine- to coarse-grained, poorly sorted, dissected alluvial-fan deposits derived from the Canyon Mountains and developed on an erosionally truncated bedrock surface west of the Sevier River; with predominantly quartzite and carbonate clasts, and locally volcanics; map unit also includes high-level alluvial-fan deposits along the southeast margin of the Gilson Mountains with primarily Paleozoic carbonate and sandstone clasts; locally consolidated; includes mixed alluvial and lacustrine deposits at distal margins below Bonneville shoreline that cannot be readily mapped; queried in one exposure near southwest corner of map area where uncertain designation; Oviatt (1992) reported unit contains Alturas volcanic ash (about 4.8 Ma) in adjacent Mills quadrangle, and a calcic soil with stage IV carbonate morphology; up to approximately 200 feet (60 m) exposed, total thickness unknown.

Unconformity

TERTIARY

Stacked-unit deposits

Ta/Kcpq$_9$ **Oldest alluvial deposits over quartzose conglomerate bed 9, Pass Canyon Member, Canyon Range Conglomerate** (Pliocene? to Miocene?/Upper Cretaceous) – Veneer of high-level fine- to coarse-grained alluvial deposits overlying bedrock unit; one area mapped in section 15, T. 15. S., R. 3 W. that stands above map unit QTaf; surficial deposit thickness probably less than 20 feet (<6 m).

Unconformity

Volcanic rocks of Sage Valley (lower Oligocene? to middle[?] Eocene) – Divided into several informal and formal (formational rank) map units in the Sage Valley quadrangle (Clark, 2003); volcanic conglomerate unit B of Clark (2003) not mapped separately in the Champlin Peak quadrangle; all exposures are along the east margin of the map area.

Tvu **Volcanic conglomerate unit undifferentiated** – Volcanic conglomerate belonging to units A, B, and/or C, but where the position within the volcanic rocks of Sage Valley cannot be determined; forms rubble-covered slopes; crops out in one area near east map border and south of Sevier River; about 50 feet (15 m) exposed, total thickness unknown.

Tvc **Volcanic conglomerate unit C** (lower Oligocene? to upper Eocene) – Poorly consolidated, brownish-gray- to moderate-brown-weathering volcanic conglomerate and breccia, with dark gray to dark pink, angular to subrounded volcanic clasts and minor carbonate and quartzite clasts; similar to unit A (see below); rubbly slope-forming exposures; likely distal alluvial deposits and lahars shed southward from the Tintic Mountains volcanic area; less than 20 feet (<6 m) exposed in one area on east map border; incomplete thickness of 400 feet (120 m) in Sage Valley quadrangle (Clark, 2003).

Fault

Tvf **Fernow Quartz Latite** (upper Eocene) – Light- to medium-gray, porphyritic, moderately to densely welded, rhyolitic ash-flow tuff in a simple cooling unit; crystal rich (about 50%) with phenocrysts of quartz, plagioclase, sanidine, biotite, and hornblende in a glassy groundmass; locally contains black to gray glassy fiamme forming a eutaxitic texture, with lapilli and up to block-sized lithic fragments; typically crops out as rounded cliffs and large boulders, but the lone exposure in this quadrangle is poor; $^{40}Ar/^{39}Ar$ age of 34.83 ± 0.15 Ma in Sage Valley quadrangle (Clark, 2003) and 34.94 ± 0.10 Ma in Tintic Mountain quadrangle (UGS & NMGRL, 2007); source likely caldera in Furner Ridge and Tintic Mountain quadrangles to the north (J.D. Keith, Brigham Young University, verbal communication, 2004); less than 50 feet (15 m) exposed in the Champlin Peak quadrangle, regional thickness up to 1500 feet (460 m) (Morris, 1977; Clark, 2003).

Fault

Tvs **Tuff of Little Sage Valley** (middle Eocene) – Grayish-pink to light-gray, poorly to moderately welded, dacitic ash-flow tuff; phenocrysts of plagioclase, quartz, sanidine, and conspicuous (10%) biotite; $^{40}Ar/^{39}Ar$ age of 37.43 ± 0.18 Ma in Sage Valley quadrangle (Clark, 2003); source unknown, localized in extent; the few exposures along east border of the quadrangle are poor; less than 50 feet (15 m) exposed; complete unit thickness from 100 to 500 feet (30-150 m) (Clark, 2003).

Tva **Volcanic conglomerate unit A** (middle Eocene) – Bouldery exposures of brownish-gray to moderate-brown-weathering volcanic conglomerate with interlayered lava flows (Tvaf); conglomerate contains dark-gray to dark-pink, angular to subrounded volcanic clasts and minor carbonate and quartzite clasts in matrix of tuffaceous sandstone and ash; contains intermediate-composition lava flow boulders; forms rubbly slopes; exposed on east map border and northwest of Dog Valley Wash; less than 50 feet (15 m) exposed; unit from 175 to 1000 feet (55-300 m) thick in Sage Valley quadrangle (Clark, 2003).

Tvaf **Lava flow member** (middle Eocene) – Mapped separately where thicker and better exposed; lava flows are generally aphanitic, of intermediate composition, and mostly fractured; flows range from pink-gray to bluish-gray to dark-gray and weather to various shades of brown and gray; forms broken exposures of angular pebbles to boulders; geochemical analysis of sample CP-4 in table 2; possible source vent in Jericho or Furner Ridge quadrangles (Clark, 2003); exposed thickness of flows less than 20 feet (6 m); from 0 to 200 feet (0-60 m) thick in Sage Valley quadrangle (Clark, 2003).

Not in contact

Tgs **Sage Valley Limestone Member of the Goldens Ranch Formation** (middle Eocene) – Upper member of the Goldens Ranch Formation of Meibos (1983), an original member of Muessig's (1951) Golden's Ranch Formation, and included as a member of the Copperopolis Latite by Morris (1977); yellowish-gray to light-olive-gray, thinly to thickly bedded, lacustrine limestone, locally includes conglomerate lenses; ledge-forming vuggy limestone containing plant remains and chert; both indirectly (where Hall Canyon Conglomerate Member present) and directly overlies the Chicken Creek Tuff Member of the Goldens Ranch Formation (38.61 ± 0.13 Ma) in Sage Valley quadrangle (Clark, 2003); an outcrop near Utah State Route 132 was removed for use by the Intermountain Power Plant in flue gas desulfurization (B.T. Tripp, Utah Geological Survey, verbal communication, 2004); only about 25 feet (8 m) exposed in two outcrops along Dog Valley Wash; regional thickness up to 300 feet (90 m) (Clark, 2003).

Not in contact

Tcw **Conglomerate of West Fork Reservoir** (middle Eocene?) – Informal unit name after Clark (2003); poorly consolidated conglomerate weathering greenish gray, brownish gray, and pinkish gray; includes predominantly quartzite clasts (Mutual and Prospect Mountain) and andesitic volcanic clasts, locally Paleozoic carbonates; clasts are subangular to subrounded cobbles and boulders; slope-forming unit present in Sevier Canyon; appears limited in lateral extent; unconformable(?) lower contact with map unit TKr based on changes in color and clast composition; a western or northern source suggested by Clark (2003); directly underlies Chicken Creek Tuff Member of the Goldens Ranch Formation (38.61 ± 0.13 Ma) in Sage Valley quadrangle (Clark, 2003); a volcanic clast from unit Tcw (sample CP-3) yielded a disturbed $^{40}Ar/^{39}Ar$ age of approximately 37.86 ± 0.30 Ma (from clast groundmass concentrate) (UGS & NMGRL, 2007); geochemical analysis of clast sample CP-3 in table 2; along with unit TKr, is current source of silica for Ash Grove Cement (from Nielson Pit 2 quarry in Jericho quadrangle near intersection of sections 1, 2, 11, 12, T. 14 S., R. 3 W.) (Aaron Bufmack, Ash Grove Cement Company, verbal communication, 2004); up to about 200 feet (60 m) exposed in quadrangle; total unit thickness to east 0 to 1300 feet (400 m) (Clark, 2003).

Unconformity?

TERTIARY-CRETACEOUS

TKbx **Silica breccia** (Oligocene? or Eocene? to Upper Cretaceous?) – Typically moderate brown to dusky red, dense, vitreous, siliceous breccia; present along Dog Valley Wash and junction of Leamington and Sevier Canyons; "overprints" rock units as young as TKr; mapped as a separate unit where bedrock host is not recognizable, "s" added to map unit symbol where bedrock can be identified; origin unknown, but location suggests it is related to movement on the Leamington Canyon fault zone, which according to Lawton and others (1997) may have begun to form early in the depositional history of the Canyon Range Conglomerate, possibly at the start of the Late Cretaceous; less likely is that the breccia is related to Tertiary volcanism; also mapped along an apparent out-of-syncline thrust fault in section 12, T. 14 S., R. 3 W.; thickness variable and uncertain.

TKr **Red beds of Sevier Canyon** (Eocene or Paleocene[?] to Upper Cretaceous?) – Informal unit name after Clark (2003); equivalent to Tr unit of Lawton and others (1997), and upper part of conglomerate of Leamington Pass map unit of Higgins (1982); poorly to moderately consolidated, moderate-reddish-orange-weathering, quartzite-clast conglomerate, sandstone, and mudstone; overlain by tan and red mudstone, pebble and cobble conglomerate, mudstone, and a local thin platy limestone with gastropods; forms ledges and slopes, exposed in Sevier Canyon and Dog Valley Wash; queried where uncertain designation; contact with underlying map unit Kcpq$_9$ is an angular unconformity; age and correlation uncertain, possibly correlates with North Horn Formation and/or Flagstaff Formation/Limestone to the east (Clark, 2003); along with unit Tcw, current source of silica for Ash Grove Cement from Nielson Pit 2 quarry in Jericho quadrangle; approximately 1000 to 2000 feet (300-600 m) thick in this quadrangle.

Unconformity

CRETACEOUS

Canyon Range Conglomerate (Paleocene[?] or Upper Cretaceous [Maastrichtian?] to Lower Cretaceous [Albian?]) – Previously referred to as the Indianola group(?) (Christiansen, 1952), Canyon Range fanglomerate (Armstrong, 1968), Canyon Range formation (Stolle, 1978), Canyon Range Formation (Holladay, 1984), Canyon Range conglomerate (Michaels and Hintze, 1994), and Canyon Range Conglomerate (Lawton and others, 1997). Replaces the lower part of conglomerate of Leamington Pass map unit of Higgins (1982). Lawton and others (1997) previously divided the formation into numerous informal lithostratigraphic units of member rank (also referred to as lithosomes) in the Canyon Mountains. Lawton and others (2007) developed a new stratigraphic terminology including five formal members with the prior members/lithosomes changed to informal bed rank. These map units are based on physical stratigraphy and three petrofacies defined by the relative proportions of quartzite and carbonate clasts (quartzite, mixed [quartzite/carbonate/sandstone], carbonate); not all of the Canyon Range Conglomerate members are exposed in this quadrangle. Bed Kclm$_4$ provides the basis for physical correlation in the Canyon Mountains. Beds underlying Kclm$_4$ in the Canyon Range syncline of the hanging wall (Canyon Range thrust) were identified by counting downward and were probably never continuous with their roughly correlative counterparts on the eastern range front.

Quartzose petrofacies almost exclusively contain quartzite clasts and generally consist of poorly sorted, clast-supported cobble and boulder conglomerates with bedsets up to 30 feet (10 m) thick, and bed bases that are sharp and erosive. These quartzite conglomerate beds are more laterally restricted than the mixed-clast variety, typically pinch out between mixed-clast petrofacies, and beds Kccq$_4$, Kchq$_5$, Kclq$_7$ are locally sourced. Mixed petrofacies have quartzite and Paleozoic carbonate/sandstone clasts in subequal amounts, and are dominantly pebble and cobble conglomerate. Carbonate petrofacies consist of pebble to boulder conglomerate of Paleozoic clasts, and are restricted to part of the eastern range front south of the Champlin Peak quadrangle.

The Canyon Range Conglomerate was deposited in interfingering alluvial-fan and braided-fluvial environments (DeCelles and others, 1995); southeasterly sediment transport is indicated (Lawton and others, 2007). Contacts between beds are typically marked by conspicuous changes in particle size, rounding, and sorting. Beds are locally separated by surfaces marked by pedogenesis and early cementation.

These synorogenic rock units contain progressive unconformities and growth structures that record the evolution of compressional structures. Growth strata are locally present in amalgamated complexes of quartzose beds. These growth strata, which indicate concurrent deposition and structural deformation, take the form of dip "fans," in which successively younger beds dip progressively less steeply than underlying beds. The contacts separating the beds are thus angular unconformities (for example, between beds Kccq$_4$ and Kchq$_5$ northeast of cement plant), which become increasingly concordant with distance from the growing structure or uplift. An example of this is the base of Kclq$_7$, which is an angular unconformity with a discordance of as much as 15 degrees with the underlying strata of bed Kchq$_5$ in the northern part of the Fool Creek Peak quadrangle, but which is concordant where the contact enters the southern part of the Champlin Peak quadrangle in section 20, T. 15 S., R. 3 W. Furthermore, Kchq$_5$ and Kclq$_7$ interfinger extensively in the southern part of the quadrangle near Leamington Pass and thus illustrate the potential lateral variability of contacts in these alluvial and fluvial conglomeratic rocks. Large coherent, brecciated slide blocks (labeled "blocks" on map), typically Paleozoic quartzite or limestone, locally lie on the upper surfaces of the quartzose petrofacies. Evidence indicates that unconformities are at the base of most of the Canyon Range Conglomerate beds, most conspicuously underlying beds Kcpq$_9$, Kclq$_6$, Kclm$_4$, Kchq$_5$, Kchm$_3$, Kccq$_4$, and Kccm$_2$. All of these beds except Kcpq$_9$ directly overlie Paleozoic strata at least locally; Kcpq$_9$ overlies Kclm$_5$ with angular discordance and truncates strata of Kclm$_5$, a relationship best displayed in section 9, T. 15 S., R. 3 W.

Lawton's unpublished mapping (for Lawton and others, 1997) in the Fool Creek Peak quadrangle to the south indicates that Canyon Range Conglomerate map units from the base upward through Kclq$_6$ and into Kclm$_5$ are involved in folding of the Canyon Range syncline, while overlying map units generally form an overlap assemblage on the folded rocks (see cross section A-A'). The Canyon Range Conglomerate lies in angular unconformity on Cambrian strata of the Canyon Range thrust plate (map units described below). These rock units crop out as ragged to rounded cliffs and ledges and also form slopes along the crest and east flank of the Canyon Mountains.

The ages shown on the lithologic column are interpretive and are based on correlation with Canyon Range Conglomerate units in the Pahvant Range and Valley Mountains (refer to figures 3 and 7 of Lawton and others, 2007); the map units in the Canyon Mountains have not been directly dated through paleontologic or other means.

Thicknesses of map units are quite variable along strike (refer to table 1 and cross section A-A'). The total thickness of the formation in the Champlin Peak quadrangle is estimated from cross sections as up to approximately 10,000 feet (3050 m); in general, the unit thickens southeastward in the subsurface. The Canyon Range Conglomerate is divided into the following formal members and informal beds after Lawton and others (2007) in the Champlin Peak quadrangle:

Kcwm$_6$ **Wide Canyon Member, red mixed conglomerate and sandstone (bed m$_6$)** – Red to brown pebble conglomerate and sandstone with abundant upper Paleozoic clasts; contains approximately 80% carbonate clasts, of which 1/3 are dolostone and 2/3 are limestone, and 20% quartzite clasts; conspicuous sandstone interbeds as much as 6 feet (2 m) thick overlie conglomerate beds and give the member a well-bedded aspect; conglomerate is locally cross-bedded; locally imbricated clasts indicate southeast paleodispersal; exposed only in southernmost part of quadrangle, but crops out extensively on east side of Canyon Mountains in Fool Creek Peak quadrangle to south; equivalent to the lower part of the North Horn Formation of Hintze and Davis (2003), possibly equivalent to red beds of Sevier Canyon (TKr); 0 to approximately 1000 feet (0-300 m) thick.

Kcpq$_9$ **Pass Canyon Member, orange quartzose conglomerate (bed q$_9$)** – Unit referred to as Kcq$_8$ in Lawton and others (1997); orange-weathering quartzite cobble and boulder conglomerate on eastern slope of Canyon Mountains in the quadrangle; contains meter-scale rounded clasts of Prospect Mountain, Mutual, and white quartzite (possibly Caddy Canyon) in matrix of tan coarse-grained sandstone; contains growth structures (see Lawton and others, 1997, figure 2 and p. 50; Lawton and others, 2007); tan Prospect Mountain clasts typically dominate the conglomerate, ranging in abundance from 50-80%; south of the Leamington Pass Road, it consists of poorly sorted, subangular to subrounded pebbles and large cobbles (9 inches diameter [23 cm]) in 20-25% matrix of coarse-grained sandstone locally stained with pervasive red-brown hematite cement; angular fragments of white to light-gray chert as much as 1 inch (3 cm) in diameter are present in the sandstone matrix; uncommon sandstone beds are laminated to convolute; upper part is white-weathering, matrix-poor cobble and boulder conglomerate, locally containing 40% clasts of Pioche Formation, which are recognized by their reddish-purple color and *Skolithos* burrows; basal contact with underlying units is an angular unconformity with discordance ranging from slight to about 15 degrees and increasing northward from southern part of quadrangle where it overlies Kclm$_5$, toward the Sevier River where it overlies the older Kchq$_5$; a conspicuous progressive unconformity is present in Kcpq$_9$ at the Sevier River (Soma siding) where strata within the conglomerate member decrease in dip upward through the section (Lawton and others, 1997, figure 15); the strata are folded into an antiform over a likely reverse fault in the steep west limb of the previously formed Canyon Range syncline; stratal dips within the member decrease abruptly from 36 to 17 degrees on the main ridge southeast of the cement quarry, suggesting that growth structures are present there as well; may be partial equivalent of Castlegate Sandstone in central Utah (Lawton and others, 2007); up to about 3000 feet (0-915 m) thick.

Unconformity

Leamington Canyon Member: Divided into several beds mapped separately including q$_8$, q$_7$, m$_5$, q$_6$, and m$_4$.

Kclq$_8$ Quartzose conglomerate with Prospect Mountain clasts (bed q$_8$) – Cross section only; may be present in the subsurface of the Champlin Peak quadrangle; restricted to an alluvial-fan deposit of limited extent in Fool Creek Peak quadrangle to the south (Lawton, unpublished mapping, for Lawton and others, 1997).

Unconformity

Kclq$_7$ **Quartzose conglomerate west of Wild Horse Peak (bed q$_7$)** – White-weathering, very thick bedded cobble and boulder conglomerate with depositional locus to south near Wild Horse Canyon in Fool Creek Peak quadrangle; best developed in section 34, T. 14 S., R. 3 W. and section 3, T. 15 S., R. 3 W.; contains conspicuous, large-scale convolute laminae due to catastrophic dewatering in SW1/4 section 34 where it is overlain by Kcpq$_9$; basal contact is an angular unconformity west of Wild Horse Peak in northern part of Fool Creek Peak quadrangle; this contact grades to a concordant, perhaps conformable, contact in the southern part of the Champlin Peak quadrangle; forms an outcrop of consistent thickness to the south edge of the quadrangle where it interfingers with mixed-clast conglomerate of Kclm$_5$; quartzite-boulder beds in zone of interfingering are conspicuous red-weathering intervals that extend northward to the vicinity of the Leamington Pass Road where they become too thin to map accurately; contains growth structures; thickness from 0 to 1000 feet (0-300 m) in area.

Local angular unconformity

Kclm$_5$ **Mixed conglomerate and lenses of quartzose pebble sandstone (bed m$_5$)** – Pebble and cobble conglomerate with laterally extensive lenses of quartz-rich pebbly sandstone; consists of upward-fining cobble-pebble successions 3 to 10 feet (1-3 m) thick interbedded with 24- to 30-inch (60-75 cm) beds of medium-grained sandstone with trough cross-beds and horizontal lamination; some beds of pebble conglomerate are horizontally laminated and cross-bedded; clasts include gray and brown dolostone, sandy dolostone (Guilmette Formation), light-gray cherty dolostone with brachiopods and crinoids, black to dark-gray limestone with light- and dark-gray chert, and white quartzarenite (Eureka or Cove Fort Quartzites); approximate clast percentages are 60% dolostone, 40% limestone, 1% chert, and 1% white quartzarenite; Mutual and Prospect Mountain quartzite clasts and Cambrian limestone clasts are present but subordinate; thickest in south part of quadrangle where it interfingers with Kclq$_7$ south of Leamington Pass, from 0 to 4500 feet (0-1370 m) thick in quadrangle.

Kclq$_6$ **Quartzose boulder and cobble conglomerate (bed q$_6$)** – Red- and white-weathering boulder and cobble conglomerate; thickest in northeastern part of quadrangle, especially in section 34, T. 14 S., R. 3 W., where lower part consists of red-weathering boulder conglomerate with abundant red sandstone matrix containing angular blocks of Pioche Formation as much as 13 feet (4 m) long; this basal conglomerate contains blocks and clasts of carbonate-pebble conglomerate derived from the underlying unit (Kclm$_4$), and fills a valley cut into Kclm$_4$ in SW1/4 section 34, with angular discordance of 13 degrees; this basal interval also contains angular clasts of botryoidal hematite, as well as well-rounded and broken-rounded quartzite clasts presumably derived from underlying conglomerate beds; upper part is somewhat finer grained, consisting of cobbles and boulders, and contains abundant clasts of fine-grained white quartzite (Caddy Canyon?); Kclq$_6$ apparently thins southwestward across the quadrangle (below tongue of Kclm$_5$) to form a thin, yet conspicuous unconsolidated boulder conglomerate that overlies a red-weathering zone in carbonate pebble conglomerate of Kclm$_4$ in the southern part of the quadrangle; this red zone is probably a prolonged exposure surface; 0 to 700 feet (0-215 m) thick.

Unconformity

Kclm$_4$ **Mixed conglomerate (bed m$_4$)** – Pebble and cobble conglomerate, dominated by carbonate clasts; clast-supported; clasts are dominantly dolostone, including gray and brown coarsely crystalline dolostone, some containing spaghetti-like stromatoporoids (Simonson Dolomite and Guilmette Formation), finely-crystalline pink dolostone, uncommon brownish-gray limestone with rugose corals (Mississippian?), and a few percent of white (Eureka) and tan (Guilmette Formation and Cove Fort Quartzite) quartzarenite with scattered, frosted spherical grains; clasts dominantly derived from Ordovician-Mississippian strata; clasts imbricated near radio tower north of Leamington Pass; conspicuous beds as much as 3 feet (1 m) thick of pink, laminated and ripple cross-bedded sandstone; thickness 0 to 1200 feet (0-370 m).

Unconformity?

Wild Horse Canyon Member: Divided into two beds mapped separately including q$_5$ and m$_3$.

Kchq$_5$ **Quartzose boulder cobble and pebble conglomerate (bed q$_5$)** – Poorly sorted red- and white-weathering boulder conglomerate with abundant clasts of Precambrian and Cambrian quartzite; contains Paleozoic quartzite and limestone slide blocks in section 4, T. 15 S., R. 3 W.; near the quarry on the Sevier River at Soma, it directly overlies the Prospect Mountain Quartzite and consists mostly of cobbles and boulders of Prospect Mountain in a matrix of poorly-sorted reddish-brown silty sandstone; an interval of brecciated carbonate ***slide blocks*** is present along strike at the upper contact of Kchq$_5$ with Kclm$_4$ and extending southwest beyond the pinchout of Kchq$_5$ along the contact between Kchm$_3$ and Kclm$_4$; blocks consist of light- to medium-gray limestone, probably Howell Limestone, about 30 feet (10 m) thick and 80 to 650 feet (25-200 m) long, with the longest blocks in the northeast and smallest in the southwest, beyond the pinchout of Kchq$_5$; fractures on upper surfaces of blocks are filled with red silty sandstone and overlain by pebble conglomerate; they are commonly flanked by unsorted breccia with millimeter- to centimeter-scale angular limestone fragments cemented by pink, finely crystalline calcite with uncommon spar-filled vugs as much as 3 mm across; locally the blocks are cut by down-to-the-southwest normal faults that do not cut the adjacent conglomerate beds and with the gap above the down-dropped block filled with laminated coarse-grained pink sandstone overlain by limestone breccia; these blocks are interpreted as rock-avalanche deposits transported generally to the southwest or south and lying near the tip of the alluvial fan represented by Kchq$_5$; Kchq$_5$ from 0 to 1000 feet (0-300 m) thick.

Unconformity

Kchm$_3$ **Mixed cobble conglomerate and sandstone (bed m$_3$)** – Pebble and cobble conglomerate locally containing boulders in red sandstone matrix in lower part; upper part is clast-supported pebble conglomerate in tabular beds as much as 20 inches (50 cm) thick; clasts include 60-70% limestone derived from Cambrian strata, including cherty oolitic limestone, gold and blue-gray mottled limestone, and crinkly-bedded medium-gray and tan limestone; some limestone clasts are as large as 3 feet (1 m) in diameter; correlative strata in northern part of Fool Creek Peak quadrangle to south contain fan-delta deposits of inferred Turonian age by correlation with palynomorph-bearing strata in exploration wells southeast of Canyon Mountains (DeCelles and others, 1995); overlies Kccm$_2$ and along strike rests directly on Cambrian carbonate strata in section 8, T. 15 S., R. 3 W. where red sandstone fills fractures and the basal part of the map unit contains abundant quartzite boulders; above the basal conglomerate is a deposit 30 feet (10 m) thick of meter-scale brecciated ***slide blocks*** of Cambrian limestone (Swasey and Howell Limestone) and dolostone in a sandstone matrix; Kchm$_3$ pinches out northeastward between Kccq$_4$ and Kchq$_5$; thickness 0 to 300 feet (0-90 m).

Cow Canyon Member: Divided into several beds mapped separately including q$_4$, m$_2$, m$_1$, q$_3$, c$_2$, q$_2$, c$_1$, q$_1$, and m$_0$ (not all present in Champlin Peak quadrangle).

Kccq$_4$ **Quartzite-boulder conglomerate and red sandstone with quartzite cobbles (bed q$_4$)** – Poorly sorted quartzite-boulder conglomerate with abundant angular boulders of Prospect Mountain Quartzite and Mutual Formation, which give conglomerate a purple and white color; in the north, directly overlies Prospect Mountain Quartzite (section 27, T. 14 S., R. 3 W.), but to south overlies Cambrian strata and pinches out to southwest above Kccm$_2$; evidently fills valleys cut into the Prospect Mountain Quartzite because it is locally absent in SW¼ section 27, T. 14 S., R. 3 W. beneath member Kchq$_5$ where the latter unconformably overlies the Prospect Mountain Quartzite; unconformity beneath Kccq$_4$ truncates member Kccm$_2$ in NE1/4 section 4, T. 15 S., R. 3 W.; forms the lower part of a progressive unconformity on the boundary between sections 33 and 34, T. 14 S., R. 3 W. where it contains three conglomerate intervals that decrease in dip from vertical to about 72 degrees southeast and is unconformably overlain by Kchq$_5$, which dips 50 degrees to the southeast (Lawton and others, 2007); a single large ***slide block*** lies near the southwestern pinchout of Kccq$_4$ (SW1/4 section 4, T. 15 S., R. 3 W.) and is 1300 feet (400 m) long and consists of brecciated Cambrian Swasey Limestone; at the pinchout of the unit are large boulders of Prospect Mountain Quartzite up to 10 feet (3 m) long (90%) and subequal quantities (5% each) of red quartzite with white quartz pebbles (Mutual Formation) and purplish-red quartzite (Pioche Formation); 0 to 600 feet (0-180 m) thick.

Unconformity

Kccm$_2$ **Mixed cobble and boulder conglomerate (bed m$_2$)** – Red-weathering pebble- to boulder-conglomerate rich in limestone clasts; oldest(?) exposed conglomerate member in the quadrangle, it directly overlies vertical to overturned undifferentiated Cambrian carbonate strata (Ꞓum) that contain abundant vertical fractures filled with pebbly sandstone in sections 3, 4, and 8, T. 15 S., R. 3 W.; the angular discordance between Paleozoic strata and Kccm$_2$ is generally 40 degrees; the map unit occupies a steep-walled valley fill about 10,000 feet (3,000 m) wide in strike dimension and is truncated beneath Kccq$_4$ at its northeastern extent and beneath Kchm$_3$ at its southwest termination in Wood Canyon; dominantly limestone clasts, including thin-bedded crinkly and mottled gray varieties, and common dolostone clasts, including light-gray cryptocrystalline (Sevy Dolomite) and mottled brown coarsely crystalline, and dark- and light-gray mottled varieties in a pink sandy siltstone matrix; large boulders of Prospect Mountain and Mutual quartzite and blocks of undifferentiated Cambrian carbonate as much as 8 feet (2.5 m) long are present near the base of the map unit; near the head of Wood Canyon, the conglomerate contains boulders (20 to 40 inches [50-100 cm] in diameter) of dolostone-pebble conglomerate eroded from older conglomerate beds not now exposed in the quadrangle; ***slide blocks*** of Cambrian carbonate strata, mostly Swasey Limestone, are common in the lower part of Kccm$_2$ with blocks oriented parallel with bedding and as much as 1000 feet (300 m) long and 30 feet (10 m) thick; the blocks are extensively brecciated, with brecciation being more extensive and pervasive in the lower parts of the blocks, such that texture ranges from monomictic carbonate breccia with an "injected" sandstone matrix near block bases to fractured carbonate in upper parts; the slide blocks occupy a single stratigraphic horizon about 65 feet (20 m) above the base of Kccm$_2$; the slide block horizon also contains deposits of angular monomictic carbonate breccia in a reddish-brown sandstone matrix; the breccia is 100 to 130 feet (30-40 m) thick, locally rests directly on subjacent Paleozoic strata and locally buries the slide blocks; the slide blocks and breccia are deposits of rock and debris avalanches locally derived from Paleozoic strata of the hanging wall of the Canyon Range thrust; Kccm$_2$ thickness 0 to 1000 feet (0-300 m).

Kccm$_1$ Mixed pebble and boulder conglomerate (bed m$_1$) – Cross section only. Exposed to south in the Cow Canyon and Little Oak Canyon area of the Fool Creek Peak and Williams Peak quadrangles (see Lawton and others, 1997; Lawton and others, 2007).

Kccq$_3$ Quartzite-cobble and boulder conglomerate (bed q$_3$) – Cross section only. Exposed to south in the Cow Canyon and Little Oak Canyon area of the Fool Creek Peak and Williams Peak quadrangles (see Lawton and others, 1997; Lawton and others, 2007).

Not present in the Champlin Peak quadrangle; mapped to the south in the Canyon Mountains:

Kccc$_2$ Dolostone pebble and boulder conglomerate at Little Oak Canyon (bed c$_2$) – Conglomerate exposed in the Cow Canyon and Little Oak Canyon area (Fool Creek and Williams Peak quadrangles).

Kccq$_2$ Quartzite-cobble and boulder conglomerate (bed q$_2$) – Conglomerate exposed in the Cow Canyon and Little Oak Canyon area (Fool Creek and Williams Peak quadrangles).

Kccc$_1$ Carbonate conglomerate with slide block of Paleozoic limestone (bed c$_1$) – Conglomerate with slide block of Paleozoic (Ordovician?) limestone exposed in the Cow Canyon and Little Oak Canyon area (Fool Creek and Williams Peak quadrangles).

Kccq$_1$ Red quartzite-boulder and cobble conglomerate at Little Oak Canyon (bed q$_1$) – Conglomerate exposed in Little Oak Canyon (Williams Peak quadrangle).

Kccm$_0$ Basal mixed conglomerate at Little Oak Canyon (bed m$_0$) – Conglomerate exposed in Little Oak Canyon (Williams Peak quadrangle).

Not in contact or fault contact

Kcum$_x$ **Mixed conglomerate uncertain member affinity, bed m$_x$** – Mixed-clast conglomerate for which specific member and bed designations are uncertain; restricted to exposures at mouth of Sevier Canyon where it consists of limestone cobble to boulder conglomerate with some clasts exceeding 3 feet (1 m) in diameter; red sandstone matrix supports angular clasts; rare 8 inch (20 cm) interbeds of graded, matrix-rich, angular pebble conglomerate; lithologies do not appear to correspond to Kchm$_3$ or Kccm$_2$; correlation with other Canyon Range Conglomerate units unclear; outcrop of Kcum$_x$ south of Soma rail siding is interpreted to be upright, rather than overturned as reported in Lawton and others (1997, p. 50); exposed thickness up to 100 feet (30 m), total thickness unknown.

Major unconformity (Kc units unconformably overlie and are partly folded with Paleozoic and Proterozic rocks of the Canyon Range thrust plate)

PARA-AUTOCHTHON BELOW THE TINTIC VALLEY THRUST PLATE AND THE LEAMINGTON CANYON FAULT

PERMIAN

Ppg **Grandeur Member of the Park City Formation** (Lower Permian [Leonardian]) – Yellowish-light-gray to medium-gray, fine- to medium-bedded, fine- to medium-grained silty dolomite; includes many large chert nodules and some bedded chert; fetid odor on fresh surfaces; crops out in sections 11 and 14, T. 14 S., R. 3 W. in association with the Diamond Creek Sandstone; appears to conformably overlie the Diamond Creek Sandstone (see Morris and others, 1977); age from McKelvey and others (1959); top not exposed, approximately 700 feet (215 m) exposed, rather than 1870+ feet (570+ m) reported by Higgins (1982); Morris (1977) stated the thickness in the Furner Ridge quadrangle is from 750 to 960 feet (229-293 m).

Pdc **Diamond Creek Sandstone** (Lower Permian [Leonardian?]) – Yellowish-gray to grayish-orange to pinkish-red, fine- to medium-grained, friable sandstone; locally cross bedded and includes some chert; forms slopes and some rounded ledges in sections 11, 12, and 14, T. 14 S., R. 3 W.; disconformably overlies the Furner Valley Limestone (see Morris and others, 1977); age from Morris and Lovering (1961) and Morris and others (1977); former source of silica in Ash Grove Cement - Nielson Pit 1 quarry (section 11, T. 14 S., R. 3 W.) (B.T. Tripp, Utah Geological Survey, written communication, December 4, 1992); approximately 855 feet (260 m) thick per Higgins (1982); thickness in the Furner Ridge quadrangle is 685 to 875 feet (209-267 m) (Morris, 1977).

PERMIAN-PENNSYLVANIAN

Oquirrh Group

PIPfv **Furner Valley Limestone** (Lower Permian and Upper Pennsylvanian [Wolfcampian to Missourian]) – The upper formation of the Oquirrh Group in the southern East Tintic Mountains area (Morris and others, 1977); formation identification based on regional mapping and stratigraphy (see Costain, 1960; Morris, 1977; Morris and others, 1977); upper part is light-olive-gray to dark-gray, medium-bedded, fine- to medium-grained, arenaceous dolomite; lower part is medium- to dark-gray, thin- to thick-bedded, silty limestone; both parts include some chert and thin beds of fine- to medium-grained, pale-reddish-brown calcareous sandstone; fossils commonly observed include fusulinids, brachipods, corals, and bryozoan fragments; exposures along the southeastern flank of the Gilson Mountains often greatly affected by folding and faulting; queried in exposures along Dog Valley Wash where masked by siliceous cementation and brecciation; age from Morris and others (1977); appears to be correlative with parts of the Bingham Mine Formation (upper formation of the Oquirrh Group), and overlying Curry Peak and Freeman Peak Formations of the northern Oquirrh Mountains (see Welsh and James, 1961; Tooker and Roberts, 1970; Swenson, 1975); base not exposed; approximately 5600 feet (1700 m) thick per Higgins (1982); Morris (1977) reported the unit is from 5230 to 6000 feet (1594-1829 m) thick to the northeast in the Furner Ridge quadrangle.

TINTIC VALLEY THRUST PLATE

MISSISSIPPIAN

Mgb **Great Blue Formation, undivided** (Upper Mississippian) – Dark-bluish-gray to medium-dark-gray to black, thin- to thick-bedded, fine-grained, fossiliferous limestone with some chert; some interbeds of sandstone and shale in upper part; fossils abundant throughout the lower part include horn corals, brachiopods, crinoid stems, and ostracodes; forms ledgy slopes and cliffs, but no obvious shaley interval of the Chiulos Member or other member divisions observed (see Morris and Lovering, 1961; Morris, 1977); crops out over a large area of the Gilson Mountains along the Tintic Valley thrust; conformably overlies Humbug Formation (Morris and Lovering, 1961); lower contact marked by gradational change from abundant quartzose sandstone interbeds of Humbug to predominantly limestone; age from Morris and Lovering (1961); exposed thickness of approximately 1000 feet (300 m) reported by Higgins (1982), but top not exposed; 1225 feet (374 m) of Chiulos and Lower Members reported in Furner Ridge quadrangle (Morris, 1977), and about 2500 feet (762 m) thick where all four members exposed in East Tintic Mountains (Morris and Lovering, 1961).

Mh **Humbug Formation** (Upper Mississippian) – Medium-gray, medium-to coarse-grained, bioclastic limestone (~ 40%) interbedded with pale-yellowish-brown, medium-grained, quartzose sandstone (~ 60%); fossils in limestones from the lower part of the unit include crinoid stems, horn corals, and brachiopod fragments; calcite vug fillings and veinlets are common throughout the unit; crops out in the Gilson Mountains as ledgy cliffs of the Champlin Peak area, also exposed in Long and Broad Canyons and in a fault block adjacent to the Tintic Valley thrust; conformably overlies Deseret Limestone; age from Morris and Lovering (1961); approximately 820 feet (250 m) thick per Higgins (1982); thickness of 600 to 750 feet (183-229 m) in the Furner Ridge quadrangle (Morris, 1977).

Md **Deseret Limestone** (Upper Mississippian) – Upper part is dark-gray, thin- to medium-bedded, fine-grained, fissile and argillaceous limestone, and lower part of dark-gray, fine-grained, fissile, calcareous siltstone and thin-bedded, argillaceous limestone with common black chert nodules; fossils include bryozoan and brachiopod fragments and crinoid stems; slope- to cliff-forming unit; crops out east of Champlin Peak and near Long Canyon; upper contact marked by change to abundant sandstone interbeds of the Humbug; age from Morris and Lovering (1961) and Sandberg and Gutschick (1984); base not exposed, maximum exposed thickness approximately 800 feet (245 m) rather than 525 feet (160 m) reported by Higgins (1982); total unit thickness of 620 feet (190 m) reported in the Jericho quadrangle (Welsh *in* Kwon and Mitra, 2005), and 1100 feet (335 m) in the Furner Ridge quadrangle (Morris, 1977).

Units not in contact

CANYON RANGE THRUST PLATE

Cambrian stratigraphy of Higgins (1982) was adapted from that in the northern House Range (after Hintze and Robison, 1975). Cambrian and Proterozoic rock unit descriptions were modified from author Hayden (Higgins, 1982) and Hintze and Davis (2003) by author Clark. Map relations and cross-section preparation indicate that Cambrian rock units are locally structurally attenuated on the steep (west) limb of the Canyon Range syncline.

CAMBRIAN

Ꞓum **Undifferentiated carbonates** (Upper and Middle Cambrian) – Typically unfossiliferous, pale-red, weathering to pinkish-gray, indistinctly to irregularly bedded, sandy limestone; includes intervals of up to 50 percent calcareous silt interbeds up to 1 inch (3 cm) thick; limestone interbedded with medium-light-gray to grayish-orange, very thick bedded to laminated, dolomitic boundstone, and dark-gray dolomite flecked with small blebs or rods of white dolomite; crystalline calcite common in vertical fractures, irregular laminae, and nodules; forms slopes and hogback ridges; sharp and conformable contact with Wheeler Shale below; top not exposed, covered by Canyon Range Conglomerate near crest of the range; age discussed below; exposed thickness up to approximately 1600 feet (490 m) near Pass Canyon as reported by Hintze and Davis (2003), rather than the 990 feet (300 m) thickness of Higgins (1982); Higgins (1982) measured a partial section of 351 feet (107 m).

Trilobites from the *Elvinia* zone (Late Cambrian) (L.F. Hintze, Brigham Young University, written communications from A.R. Palmer, Institute for Cambrian Studies, April 2, 1999, and April 4, 1999) were obtained near Pass Canyon (sample LH-F05-05-97, SE1/4NE1/4NW1/4 section 17, T. 15 S., R. 3 W.), not from the *Crepicephalus* zone as stated in Hintze and Davis (2003, p. 56). The *Elvinia* zone indicates partial equivalence to upper Orr Formation strata in ranges to the west and southwest. The lower part of the formation (Ꞓum) locally contains polymerid trilobites and inarticulate brachipods (Middle Cambrian) (L.F. Hintze, written communication from R.A. Robison, University of Kansas, September 21, 2004) (samples from Ash Grove Cement – Hank Allen quarry, NE1/4 section 4, T. 15 S., R. 3 W.).

Ꞓwh **Wheeler Shale** (Middle Cambrian) – Light-olive-gray to olive-gray, weathering to pale-yellow-brown, partially calcareous, fossiliferous shale; shale coarsens to a calcareous siltstone in places (to 3 feet [1 m] thick) with interbeds of thinly bedded, medium-gray limestone (up to 6 feet [2 m]); nonresistant unit forms slopes covered by platy talus; lower contact with cliff-forming Swasey Limestone is gradational; fossil fauna include *Hertzina* (conodont), *Bathyuriscus, Elrathina, Kootenia, Peronopsis,* and *Ptychagnostus* (trilobites from the *Ptychagnostus gibbus* zone [Middle Cambrian]), as well as *Modocia* and *Zacanthoides* (trilobites) (J.M. Higgins, Brigham Young University, written communication from R.A. Robison, University of Kansas, 1980) and abundant sponge spicules in siltstone interbeds; 100 feet (30 m) thick per Higgins (1982) measurement; regional thickness increases to 487 feet (148 m) in the northern House Range and to a maximum of 910 feet (277 m) in the Drum Mountains (Hintze and Davis, 2003).

Ꞓs **Swasey Limestone** (Middle Cambrian) – Dark-gray to medium-dark-gray, weathering to medium-gray to medium-light-gray, thickly to very thickly bedded limestone; contains about 5 percent light-brown, silty laminae parallel to bedding; some white calcite-filled fractures; develops ledges that form a resistant ridge between two slope-forming units; lower contact placed at the base of the cliff-forming limestone; current source of high-calcium limestone in Ash Grove Cement Company – Hank Allen quarry (section 33, T. 14 S., R. 3 W.); 610 feet (186 m) measured by Higgins (1982); age from Hintze and Robison (1975); regional thicknesses of 250 feet (76 m) northern House Range, and 180 feet (55 m) Drum Mountains (Hintze and Davis, 2003).

Ꞓw **Whirlwind Formation** (Middle Cambrian) – Olive-gray, weathering to yellowish-gray and pale-orange, calcareous, slightly silty shale; contains interbeds of medium-gray limestone (4 to 20 inches [10-50 cm] thick) commonly with *Ehmaniella* (trilobite) hash in upper 100 feet (30 m); trace fossils (trails, "U"-tubes, fecal pellets) common in lower 65 feet (20 m); forms a strike valley to slope between limestone ridges of adjacent units; lower contact marked by distinct break from shale to light gray Dome Limestone cliff; *Ehmaniella* zone indicates Middle Cambrian age (Hintze and Robison, 1975); Higgins (1982) measured 144 feet (44 m); thicknesses of 147 feet (45 m) in northern House Range, and 137 feet (42 m) in Drum Mountains (Hintze and Davis, 2003).

Ꞓd **Dome Limestone** (Middle Cambrian) – Medium-gray to medium-dark-gray, weathering to light-gray, indistinctly to irregularly bedded limestone with some light-brown silty laminae parallel to bedding; some shale interbeds (up to 10 feet [3 m] thick) in upper portion; weathered surface of the limestone tends to be more rounded than the solution-pitted surface of the Howell Limestone; crops out as resistant rib or ribs between shale slopes; contact with underlying Chisholm at the base of the massive Dome Limestone cliff; former source of high-calcium limestone in Ash Grove Cement Company - Hank Allen quarry; age from Hintze and Robison (1975); thickness of 180 feet (55 m) measured by Higgins (1982); regional thicknesses of 320 feet (100 m) in northern House Range, 335 feet (102 m) in Drum Mountains, and 280 feet (85 m) in Cricket Mountains (Hintze and Davis, 2003).

Ꞓc **Chisholm Formation** (Middle Cambrian) – Olive-gray, weathering to light-olive-gray and pale-orange, calcareous and micaceous shale; 35 percent of unit is interbeds (up to 10 feet [3 m] thick) of medium-gray, weathering to light-gray, irregularly bedded limestone, with distinctive *Glossopleura* (trilobite) hash, abundant limonite-stained oncolites (0.4 to 0.8 inch [1-2 cm] diameter) and trace fossils; forms ledgy slope; lower contact somewhat gradational, but placed where shale forms break above the Howell cliff; *Glossopleura* zone indicates Middle Cambrian age (Hintze and Robison, 1975); Higgins (1982) measured 246 feet (75 m); Hintze and Davis (2003) reported thicknesses of 219 feet (67 m) in northern House Range, 205 feet (63 m) in Drum Mountains, and 215 feet (65 m) in Cricket Mountains.

Ꞓh **Howell Limestone** (Middle Cambrian) – Medium-dark-gray, weathering to medium-gray and medium-light-gray, indistinctly to irregularly bedded limestone with some siltstone partings throughout; oncolites (often limonite-stained) abundant near base and irregularly shaped silty markings common near top; forms westernmost prominent steep carbonate ridge along western flank of Canyon Mountains, with solution-pitted cliffs from 30 to 100 feet (10-30 m) high; contact with Pioche placed at lowest thicker limestone bed; former source of high-calcium limestone in Ash Grove Cement Company - Hank Allen quarry; age from Hintze and Robison (1975); 302 feet (92 m) measured by Higgins (1982); other reported thicknesses (upper member and Millard Member combined) of 645 feet (196 m) in northern House Range, 330 feet (101 m) in Drum Mountains, and 358 feet (109 m) in Cricket Mountains (Hintze and Davis, 2003).

Ꞓp **Pioche Formation** (Middle and Lower Cambrian) – Olive-gray, weathering to light-olive-gray phyllitic shale and calcareous siltstone interbedded with quartzite that is grayish-red-purple and grayish-orange, weathering to dusky-yellowish-brown and grayish-brown; quartzite is indistinctly to evenly bedded, medium to coarse grained with rounded to subangular grains, locally cross-bedded, and forms ribs or ledges in the lower and middle parts of the Pioche; a distinctive feature of the quartzite is the occurrence of small, nearly vertical, tubular *Skolithos* burrows up to 0.2 inch (0.5 cm) in diameter; contains several pebble conglomerate interbeds near base of formation and locally some thin limestone interbeds near top; trace fossils are abundant, especially in the siltstones; forms slopes and ledges in the Canyon Mountains; Higgins (1982) stated that the lower contact is gradational and placed it at the lowest occurrence of shale, but the lower contact has been mapped differently by others (see Hintze and Robison, 1975; Hintze and Davis, 2002; Hintze and Davis, 2003); age from Hintze and Robison (1975); Pioche thickness variations may be due to structural attenuation and different mapping of an interbedded quartzite and phyllitic shale interval, the unit thickness is reported as approximately 590 feet (180 m) in the Canyon Mountains by Hintze and Davis (2003), while 748 feet (228 m) were measured by Higgins (1982); regional thicknesses (Tatow Member and lower member combined) of 598 feet (182 m) in northern House Range, 415 feet (127 m) in Drum Mountains, and 809 feet (247) in Cricket Mountains (Hintze and Davis, 2003).

Ꞓpm **Prospect Mountain Quartzite** (Lower Cambrian) – Mapped as Tintic Quartzite by Higgins (1982), but Prospect Mountain is considered appropriate considering the application of other House Range Cambrian stratigraphic terminology (L.F. Hintze, verbal communication, September 2004). Grayish-orange-pink to grayish-pink to pale-reddish-purple, weathering to dark-yellow-orange and grayish-orange-pink, indistinctly to evenly bedded, locally cross-bedded, medium- to very-coarse-grained quartzite; cross-bed sets up to 8 inches (20 cm) high show alternating gray- to grayish-red-purple laminae; several metaconglomerate interbeds (up to 7 feet [2 m] thick) with quartz pebbles and granules near base, and shale interbeds at top; mainly crops out as prominent ledgy ridges and cliffs forming higher ridges along the western flank of the Canyon Mountains, and a few brecciated outcrops north of Soma siding; formation subdivided (as Tintic) in the Canyon Range culmination in the adjacent Fool Creek Peak quadrangle (Lawton, unpublished mapping, for Lawton and others, 1997); disconformable lower contact based on obvious color change of quartzite on fresh surfaces from grayish orange pink (Prospect Mountain) to reddish purple (Mutual). The Prospect Mountain Quartzite was the original source of silica at the Leamington cement plant (Hank Allen quarry area), but was found to be too abrasive to machinery for continued use (B.T. Tripp, UGS, verbal communication, November 2006). An additional aggregate or silica source is an unnamed quarry near Soma rail siding (section 22, T. 14 S., R. 3 W.); geochemical data from quarry rock included in table 3. Age from Hintze and Robison (1975); 2740 feet (835 m) measured by Higgins (1982); Hintze and Davis (2003) reported regional thicknesses of 4000+ feet (1200+ m) in Drum Mountains, and 4000 feet (1200 m) in Wah Wah Mountains.

Unconformity?

PROTEROZOIC

Proterozoic rocks mapped by author Hayden (see Higgins, 1982) on the basis of a regional study by Christie-Blick (1982) in which he correlated the Precambrian rocks of the Canyon Mountains with those in the Sheeprock Mountains to the north.

Zm **Mutual Formation** (Upper Proterozoic) – Pale-reddish-purple to grayish-red-purple, weathering to dusky red and light-brown, medium- to very-coarse-grained, indistinctly bedded quartzite with some cross-bedding (0.4 to 4 inches [1-10 cm] high); 10% interbeds of medium-red granule and pebble metaconglomerate (from a few inches to 10 feet [3 m] thick) with rounded to subangular, fractured quartzite clasts; exposed as steeply-dipping, overturned strata forming prominent ledgy ridges and cliffs to rounded knobs along and within Leamington Canyon and southward toward Pass Canyon; conformable lower contact marked by change from resistant quartzite to phyllitic shale of the Inkom Formation; age from Christie-Blick (1982); an estimated 1640 feet (500 m) thick in quadrangle per Higgins (1982), she measured an incomplete section of 1204 feet (367 m); greater thicknesses reported in Canyon Mountains are 1900 to 2475 feet (575-750 m) (Holladay, 1984) and 1750 feet (530 m) (Millard, 1983), and our cross section A-A' shows about 2200 feet (670 m); in the Drum Mountains about 3000 feet (915 m) thick (Hintze and Davis, 2003).

Zi **Inkom Formation** (Upper Proterozoic) – Micaceous, light-olive-gray to grayish-red-purple, weathering to dusky-gray-yellow and grayish-red, phyllitic shale; arenaceous in upper part; interbedded, very-fine to fine-grained, thin-bedded, very-dusky-red-purple, weathering to dusky-red quartzite more common near base; deformed bedding observed; only exposed in section 12, T. 15 S., R. 4 W. where it forms a saddle between predominantly quartzite formations; conformable contact with Caddy Canyon Quartzite marked by abrupt change from shale to quartzite; age from Christie-Blick (1982); relatively weak unit that has likely been affected by structural attenuation in quadrangle; 305 feet (93 m) measured by Higgins (1982); other reported thicknesses in Canyon Mountains of 300 feet (90 m) (Holladay, 1984) and 275 feet (84 m) (Millard *in* Hintze and Davis, 2003).

Zc **Caddy Canyon Quartzite** (Upper Proterozoic) – Pale-yellowish-orange to grayish-orange-pink, weathering to very-pale-orange and moderate-brown, poorly sorted, medium- to very-coarse-grained quartzite and lesser interbeds of phyllitic siltstone and shale; quartzite has indistinct to 5-foot-thick (1.5 m) even bedding; lower part of Caddy Canyon consists of siltstone and shale with quartzite interbeds; near base of the exposed interval is a 30-foot-thick (100 m) conglomeratic unit with quartzite clasts (1 to 2.5 inches [2-6 cm] in diameter) within a poorly sorted quartzite matrix; crops out as cliffs and some slopes along the Leamington Canyon fault north of Sevier River and one exposure adjacent to Inkom Formation south of river; queried where uncertain designation in section 21, T. 14 S., R. 3 W.; age from Christie-Blick (1982); base not exposed, truncated by Leamington Canyon fault; total thickness probably near 1930 feet (590 m) (per Millard measurement in Hintze and Davis, 2003) rather than 6600+ feet (2000+ m) reported by Higgins (1982); the apparently thicker section in Leamington Canyon is probably due to structural complications.

Leamington Canyon fault

MAP AND CROSS-SECTION SYMBOLS

Contact – Dashed where approximately located, queried where uncertain presence

Marker bed in growth-strata interval or progressive unconformity

Normal fault – Dashed where approximately located, dotted where concealed (approximately located); query indicates uncertain presence; bar and ball on down-dropped side

Steeply-dipping fault – Dashed where approximately located, dotted where concealed (approximately located)

Thrust fault – Dashed where approximately located, dotted where concealed (approximately located); teeth on upper plate; arrows show relative displacement on cross section

Reverse fault – Dashed where approximately located, dotted where concealed (approximately located); teeth on upper plate; arrows show relative displacement on cross section

Axial trace of anticline – Approximately located; arrow shows direction of plunge

Axial trace of overturned syncline – Approximately located; dotted where concealed (approximately located)

Small anticline – Arrow shows direction of plunge

B Lake Bonneville shoreline (Bonneville level) – Dashed where poorly developed, mapped at the top of the wavecut bench in surficial and bedrock units

Landslide scarp – Dashed where approximately located; hachures on down-dropped side

Slide block in Kc

TKr,s TKbx Area of silicification (s) and silica breccia (TKbx) outcrops

A A' Line of cross section

Line of measured section (see Higgins, 1982)

Strike and dip of bedding – Black symbols from Hayden, red symbols from Lawton, blue symbols from Clark, green symbols from Kwon (2004):

20 Inclined

Vertical

45 Overturned

S Quarry of Ash Grove Cement Plant – Letter for commodity: L/S = limestone and shale; L = limestone; S = silica

Other quarry

Prospect

Sand and gravel pit

LH-FO5-05-97 Fossil sample location and number

CP-4 Rock sample location and number

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Numbers correspond to index to previous geologic mapping in the Champlin Peak quadrangle and adjacent areas.

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Table 2. *Major- and trace-element whole-rock analyses.*

Sample No.	Map Unit	Rock Type	Rock Name	Latitude(N)	Longitude (W)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	Cr_2O_3	TiO_2	MnO	Ag	Ba
CP-1	-	welded tuff	dacite	39° 37'31"	112° 07'42"	65.57	15.58	3.74	3.87	1.1	2.97	3.09	0.01	0.59	0.04	<1	1040
CP-3	Tcw	clast	andesite	39° 34'59"	112° 07'30"	58.16	15.39	6.09	6.87	4.06	2.8	2.98	0.04	0.92	0.11	<1	1055
CP-4	Tvaf	lava flow	dacite	39° 37'18"	112° 08'50"	61.29	16.51	4.32	5.88	0.73	3.31	3.44	0.02	0.89	0.09	<1	1085

Sample No.	Ce	Co	Cr	Cs	Cu	Dy	Er	Eu	Ga	Gd	Hf	Ho	La	Lu	Mo	Nb	Nd	Ni
CP-1	100	7.1	30	4.4	6	4.1	2.4	1.4	21	5.5	9	0.7	61.1	0.3	2	20	38.7	9
CP-3	103	19.8	160	1.8	12	5.2	3.2	1.6	21	6.2	10	0.8	69.5	0.3	3	19	46.3	25
CP-4	121.5	11.8	40	4.3	8	5.3	3.3	1.7	25	6.8	8	0.9	64.4	0.4	2	17	44.9	9

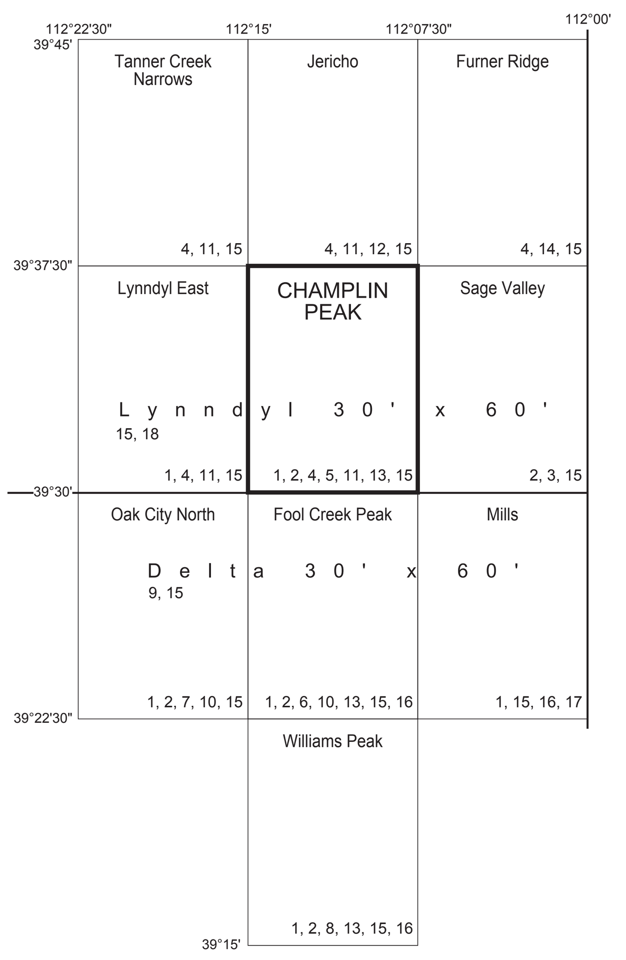
Sample No.	Pb	Pr	Rb	Sm	Sn	Sr	Ta	Tb	Th	Tl	Tm	U	V	W	Y	Yb	Zn	Zr
CP-1	30	11.6	94.6	6.7	1	524	1.2	0.7	25	<0.5	0.3	5	51	2	18.4	2.3	62	256
CP-3	41	13.6	74.5	7.7	<1	646	1	0.8	21	<0.5	0.3	3.2	99	2	20.6	2.9	101	254
CP-4	77	13.1	115.5	9	2	575	1.2	1	25	<0.5	0.4	6.6	79	1	24.5	2.7	100	272

Notes:
Oxides reported in weight percent by x-ray fluorescence (XRF); minor and trace elements reported in parts per million (ppm) by inductively-coupled plasma-mass spectrometry (ICPMS).
Analyses performed by ALS Chemex, Inc., Sparks, NV; report dated January 6, 2005.
Latitude and longitude based on NAD27.
Sample CP-1 is from the Jericho quadrangle, while CP-3 and CP-4 are from the Champlin Peak quadrangle.
Rock name using TAS diagram of LeBas and others (1986).
LOI is Loss on Ignition.

Table 3. *Major-element whole-rock analyses for Prospect Mountain Quartzite from Soma area quarry.*

Sample No.	UTM Northing	UTM Easting	SiO_2	Al_2O_3	MgO	K_2O	Cr_2O_3	Fe_2O_3	Cl	ZrO_2	SO_3	Na_2O	TiO_2
A00092	4382220	400000	97.9	1.41	0.0565	0.118	0.0673	0.479	ND	ND	ND	ND	ND
A00093	4382220	399990	97.3	1.89	0.0927	0.187	0.0709	0.462	0.0087	0.0187	ND	ND	ND
A00094	4382220	399980	98.2	0.991	ND	0.0955	0.0807	0.607	0.0122	ND	0.0377	ND	ND
A00095	4382220	399970	98.7	0.45	ND	0.0841	0.12	0.684	ND	ND	ND	ND	ND
A00096	4382220	399960	97.5	1.48	ND	0.188	0.0659	0.461	ND	0.0211	0.0347	0.0946	0.136

Notes:
Oxide and element data reported in mass percent by x-ray fluorescence (XRF).
ND = not detected.
Analyses performed December 12, 2002, by the Utah Geological Survey.
Samples collected by B.T. Tripp, UGS, on September 18, 2001.
UTM Zone 12, datum NAD27

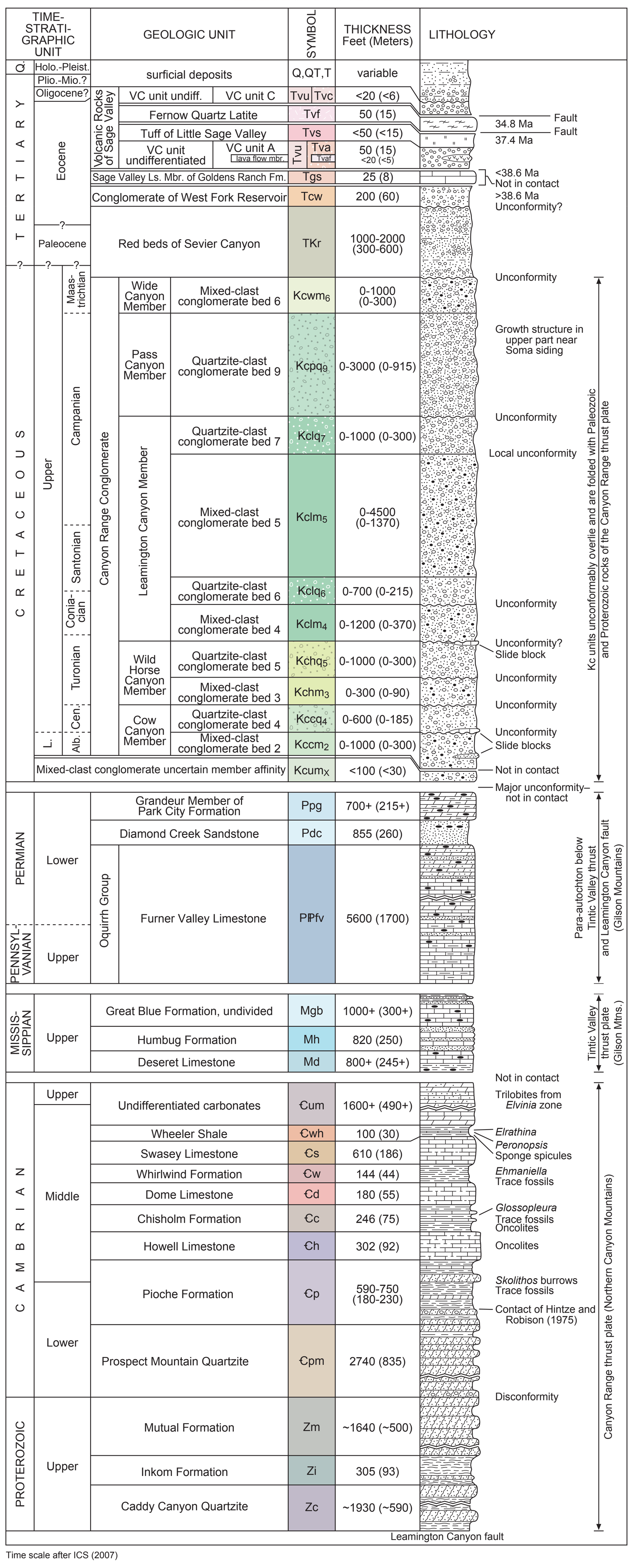


Index to previous geologic mapping in the Champlin Peak quadrangle and adjacent areas.

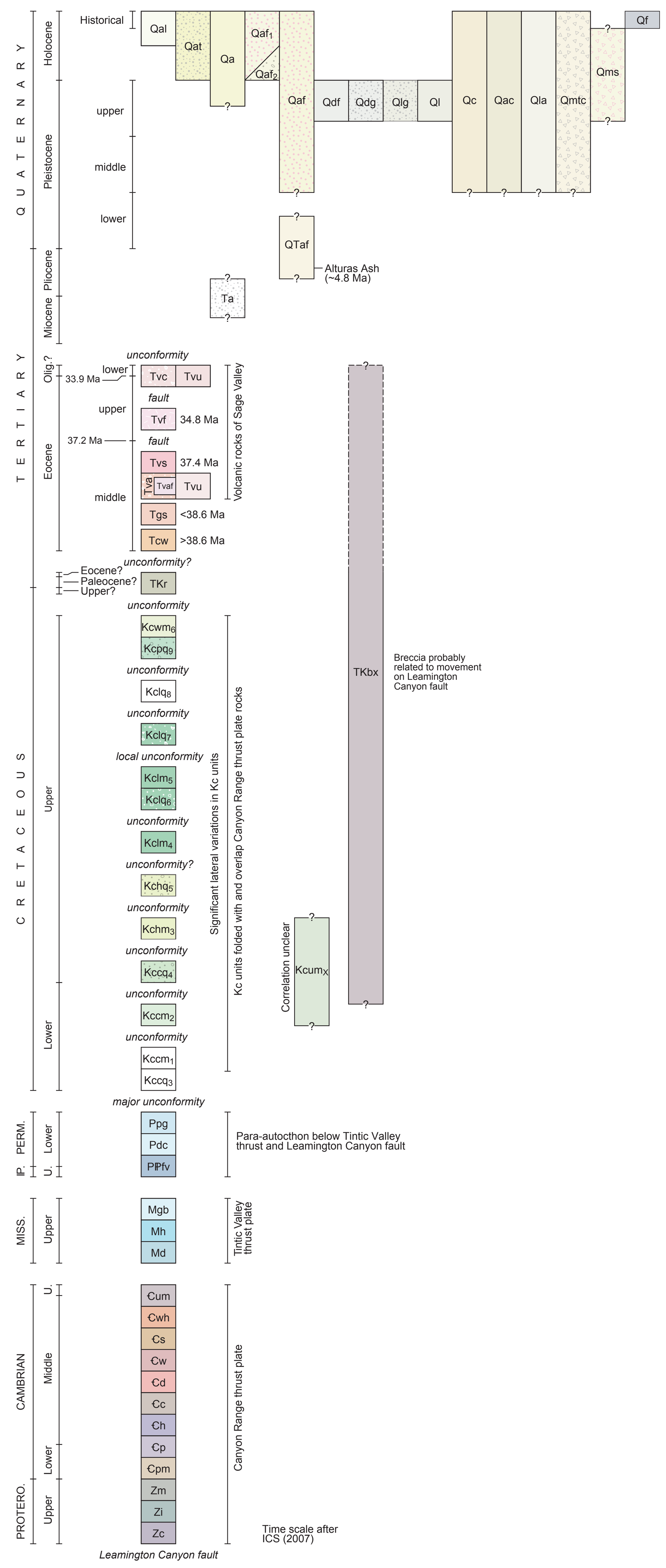
Table 1. *Comparison of Canyon Range Conglomerate map units to Higgins (1982) measured section.*

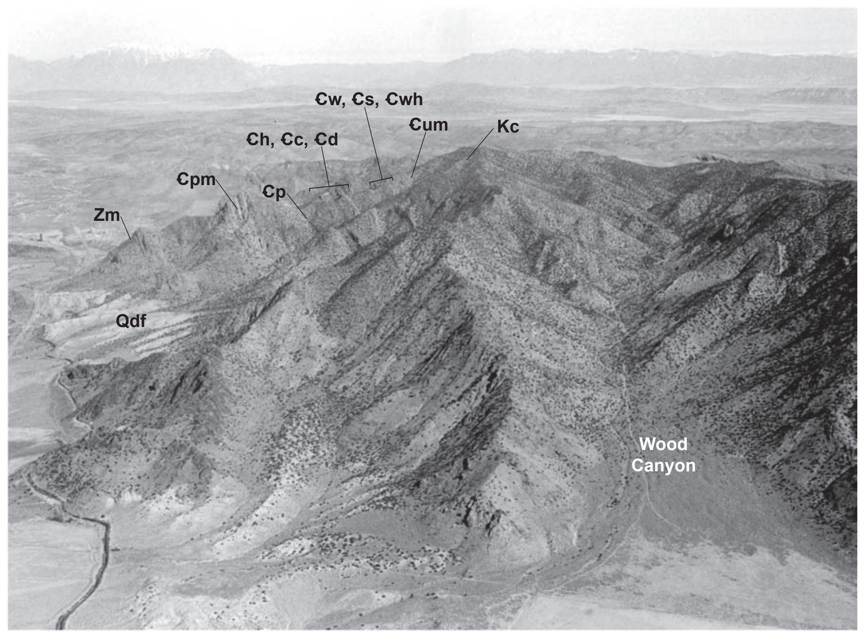
		Higgins (1982)		Map and Cross Section A-A'		
Map unit	**Higgins section units**	**feet**	**meters**	**feet**	**meters**	**Comments**
$Kcwm_6$	not measured					Lawton notes provenance in Gilson Mountains North Horn Fm. of Hintze and Davis (2002)
$Kcpq_9$	71-61	1725	526	<1750	<540	
$Kclm_5$	missing			900-3500	280-1100	
$Kclq_7$	60-59	154	47	0-350	0-110	$Kchq_5$?, Higgins missed carbonate clasts?
$Kclm_5$ lower part	missing					
$Kclq_6$	58	200	61	100-400	30-120	$Kclm_5$?, Higgins missed carbonate clasts?
$Kclm_5$? &$Kclm_4$	57-43	492	150	450-1000	140-300	57-56, $Kclm_5$, map thickness too large relative to measured thickness unless units 59-58 actually contain limestone clasts and are part of $Kclm_5$ 55-54, $Kclq_7$ 53-51, $Kclm_5$ lower tongue 50, $Kclq_6$, exaggerated thickness on map 49-45, $Kclm_4$, rugose coral (Mississippian) in 45 indicates uplift of Gilson Mountains
$Kchq_5$	missing					44, $Kchq_5$ tongue 43, $Kclm_4$ or $Kchm_3$
$Kchq_5$ & block	42	26	8	300-600	90-180	exaggerated thickness on map
$Kchm_3$	41-40	410	125	100-500	30-150	measured thickness too large relative to map thickness
$Kccq_4$ & block	39	49	15	150-500	45-150	exaggerated thickness on map
$Kccm_2$	38	394	120	600-800	180-240	
		3450	***1052***	***variable***		***total measured***

LITHOLOGIC COLUMN



CORRELATION OF MAP UNITS





Aerial view eastward of the north end of the Canyon Mountains. Cement plant and State Route 132 at left center of photo. Steeply dipping section of Proterozoic and Cambrian strata are overlain by the Cretaceous Canyon Range Conglomerate. Rock unit labels are near Higgins' line of measured section. Lighter-colored deposits are deltaic fines. Wood Canyon is in the right part of the photo. Photo by Janice Higgins.

View southwestward of the progressive unconformity (growth strata) in the Canyon Range Conglomerate along the Sevier River at the Soma rail siding. Conglomerate beds in center of photo dip steeply to view, while beds on the left decrease in dip upsection. Photo by Don Clark.